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APR 79 V N ZUEV, A N IOSHCHENKO, Y F KVASHNIN

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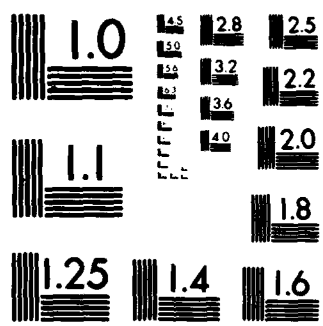

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ONE DEVICE FOR COHERENT RECEPTION OF
WIDE-BAND ORTHOGONAL SIGNALS

By

V. N. Zuev, A. N. Ioshchenko, et al

EDITED TRANSLATION

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By: V. N. Zuev, A. N. Ioshchenko, et al

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А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

ONE DEVICE FOR COHERENT RECEPTION OF WIDE-BAND ORTHOGONAL SIGNALS

V. N. Zuev, A. N. Ioshchenko, Ye. F. Kvashnin, V. L. Savinykh

We have examined the block-diagram and principles of operation of a device for coherent reception of wide-band orthogonal signals. An analysis was done of the system of separating reference voltage. Given are the results of an experimental investigation of the device.

1. Introduction

A review of present and planned wide-band systems of communications (ShSS) shows that in ShSS we use, basically, orthogonal wide-band signals, although in binary communications systems we use opposite signals (L. 1). In multi-position and address systems, we use, as a rule, orthogonal signals.

With the reception of wide-band signals, noncoherent methods find the widest use. Most frequently used is the method of synchronous heterodyning with subsequent incoherent detection. With synchronous heterodyning, we can also realize the coherent method of reception and, consequently, obtain higher noise stability. For this, we must find a simple method for separating synchronous reference

voltage for a coherent detector.

This work examines a device for coherent reception of wide-band orthogonal signals which uses one of the possible methods of separating reference voltage, and the results of its experimental checking are given.

2. Block-diagram of the device

Figure 1 gives a block-diagram of the device for coherent reception of wide-band orthogonal signals in multi-position communications systems [L. 2]. It is distinguished from the usual system of coherent reception by the presence of coherent detectors (KD) and the systems for separating the reference voltage for them. Moreover, the total spectrum of the interorthogonal wide-band signal generators Γ_1-Γ_m is shifted relative to the spectrum of received signals by some frequency Ω. Thanks to this, with the reception of signal $Z_k(t)$ at the output of the k-multiplier Π_k, a radio pulse appears with frequency Ω and duration T equal to the duration of the received signal. At the outputs of the remaining multipliers, the voltages, at this time, will be determined only by interferences.

Reference voltage of frequency Ω for coherent detection is obtained by adding the coagulated signals from the outputs of the multipliers and filtration of the obtained sum by the narrow-band filter (UPF). Since it is proposed that all signals possess equal energies and at each moment of time one of the m signals is transmitted, the amplitude of voltage at the output of the adder and the UPF will be constant. The phase shifter Φ is necessary for accurate

establishment of phase of the reference voltage of coherent detectors with tuning of the system.

3. Analysis of reference voltage-separation system.

With summation of radiopulses of frequency Ω which correspond to various signals $z_r(t)$, and subsequent one-after-another, we must ensure coherence of the filling oscillations. We will show that the radio pulses at the outputs of all multipliers from Π_1 to Π_m are coherent.

With the analysis of the diagram in Fig. 1, we will consider that the wide-band signals $z_r(t)$ are orthogonal in the strengthened sense, i.e. that we accomplish equations

$$\begin{aligned} &\int_0^T z_r(t) z_l(t)\,dt = 0, \quad r \neq l, \\ &\int_0^T z_r(t) z_l^*(t)\,dt = 0, \quad r \neq l, \end{aligned} \tag{1}$$

where $z_r(t)$, $z_l(t)$ are wide-band signals which have identical energies;

$r=1, 2, 3, \ldots, m;\ l=1, 2, 3, \ldots, m;$

$z_l^*(t)$ is the signal conjugated by Gilbert with signal $z_l(t)$.

Functions with a limited spectrum $z_r(t)$, $z_l(t)$ at interval $(0,T)$ can be presented in the form of a Fourier series [1. 3]:

$$\begin{aligned} z_r(t) &= \sum_{k=1}^{n} (a_{r_k} \cos k\omega_1 t + b_{r_k} \sin k\omega_1 t), \\ z_l(t) &= \sum_{k=1}^{n} (a_{l_k} \cos k\omega_1 t + b_{l_k} \sin k\omega_1 t), \end{aligned} \tag{2}$$

where $\omega_1 = \frac{2\pi}{T}$,

a_{r_k}, b_{r_k} and a_{l_k}, b_{l_k} - are constant coefficients.

The accepted signal $z'(t)$ can be presented in the following form:

$$z'(t) = \mu z_r(t) + n(t) = \sum_{k=k_1}^{k_2} (A_k \cos k\omega_0 t + B_k \sin k\omega_0 t), \tag{3}$$

where μ is the coefficient of transmission of the channel, and $n(t)$ is the additive interference.

Reference signals $s_l(t)$, formed by local generators Γ_1, Γ_2, ..., Γ_m are distinguished from transmitted signals $z_l(t)$ by the fact that their spectra are shifted relative to the spectra of transmitted signals by frequency $\Omega = q\omega_0$, where $q>0$ - any positive number

$$s_l(t) = \sum_{k=k_1}^{k_2} [a_{l_k} \cos (k+q)\omega_0 t + b_{l_k} \sin (k+q)\omega_0 t]. \tag{4}$$

In the multipliers, the accepted signal is multiplied with one of the reference voltages $s_l(t)$. The voltage at the output of the l-multiplier, if signal $z_r(t)$ was transmitted, is equal to

$$\begin{aligned} u_l(t) = z'(t)\, s_l(t) = \frac{1}{2} \sum_{k=k_1}^{k_2} \sum_{i=k_1}^{k_2} [& (A_k a_{l_i} - B_k b_{l_i}) \cos (k+i+q)\omega_0 t + \\ & + (A_k b_{l_i} + B_k a_{l_i}) \sin (k+i+q)\omega_0 t + \\ & + (A_k a_{l_i} + B_k b_{l_i}) \cos (i-k+q)\omega_0 t + \\ & + (A_k b_{l_i} + B_k a_{l_i}) \sin (i-k+q)\omega_0 t]. \end{aligned} \tag{5}$$

Voltages $u_l(t)$ are further fed to coherent detectors, and then to integrators which are commutated through time T. Therefore, in expression (5), we are interested only in the last two members with i=k. Then expression (5) can be transformed to form

$$u_{l_0}(t) = \sum_{k=k_1}^{k_2} [(A_k a_{l_k} + B_k b_{l_k}) \cos \Omega t + (A_k b_{l_k} - B_k a_{l_k}) \sin \Omega t]. \tag{6}$$

With the absence of interference and $\mu=1$ $z'(t)=z_r(t)$. Then, from a comparison of expressions (2) and (3) it follows that

$$A_k = a_{r_k}; \quad B_k = b_{r_k}. \tag{7}$$

Substituting (7) in (6), we obtain

$$u_{r_0}(t) = \sum_{k=k_1}^{k_2} (a_{r_k}^2 + b_{r_k}^2)\cos\Omega t \ \text{при}\ r = l, \qquad (8)$$

$$u_{l_0}(t) = \sum_{k=k_1}^{k_2} [(a_{r_k}a_{l_k} + b_{r_k}b_{l_k})\cos\Omega t + (a_{r_k}b_{l_k} - b_{r_k}a_{l_k})\sin\Omega t] \ \text{при}\ r \neq l. \qquad (9)$$

при = when

Conditions of orthogonality of (1) with consideration of (2) can be recorded in the following form:

$$\frac{T}{2}\sum_{k=k_1}^{k_2} [a_{r_k}a_{l_k} + b_{r_k}b_{l_k}] = 0 \quad r \neq l,$$
$$\frac{T}{2}\sum_{k=k_1}^{k_2} [a_{r_k}b_{l_k} - b_{r_k}a_{l_k}] = 0 \quad r \neq l. \qquad (10)$$

Full power of the r-signal P_r is equal to

$$P_r = \frac{1}{2}\sum_{k=k_1}^{k_2} (a_{r_k}^2 + b_{r_k}^2). \qquad (11)$$

With consideration of (10) and (11), expressions (8) and (9) take the form

$$u_{r_0}(t) = 2P_r\cos\Omega t, \quad u_{l_0}(t) = 0. \qquad (12)$$

From (12), it follows that the wide-band orthogonal signals $z_r(t)$ with the use of the method of synchronous heterodyning "coagulate" to synphase sinusoidal signals (t).

Consequently, in the diagram in Fig. 1, at the output of summator C the voltage with frequency Ω will be continuous in time. The UPF filters out all other frequency components. In the case of a channel with shifted parameters after the UPF, we must place the amplitude limiter for ensuring constancy of amplitude of the reference voltage of coherent detectors.

4. Experimental investigations

The authors have prepared an active model of the device for coherent reception of binary wide-band signals in a system with active pauses and manipulation with respect to form. We measured the noise stability of the developed model in relation to the fluctuation and sinusoidal interferences. Here, we used wide-band orthogonal signals "sign" and "pause" with uniform amplitude spectrum in band F=80 kHz in transmission and 200 kHz in reception. We used speeds of telegraphing of 75, 150, and 300 bauds. The reference voltage for coherent detectors with frequency $\frac{\Omega}{2\pi}$ =300 kHz was separated by a narrow-band quartz filter with a pass band of about 10 Hz.

The obtained dependence of frequency of errors on value $h = \frac{U_c}{U_n}\sqrt{FT}$ with the influence of fluctuation interference (voltage of interference was measured in the band of the signal) is given in Fig. 2 (curve 1). For a comparison, the same figure gives a dependence of the probability of errors on value h, which corresponds to the potential noise stability of binary communications systems with orthogonal signals in relation to white noise (curve 2) and noise stability of these systems with optimal coherent reception (curve 3), borrowed from [L. 3].

The action of concentrated interference on a wide-band communications system, as is known [L. 3], is equivalent to the action of fluctuation interference of the same power. The experimental curve which characterizes the noise stability of the model in relation to the sinusoidal interference, practically coincides with curve 1 and, therefore, does not occur individually. From a comparison

of the curves in Fig. 2, it is obvious that in this device we obtain higher noise stability than with optimal incoherent reception and close to potential.

5. Conclusion

The developed device realizes a coherent method of reception of wide-band orthogonal signals, which is supported by the results of experimental investigations. The noise stability of the device is close to the potential noise stability of communications systems with orthogonal signals.

The practical realization of the device, particularly the system of separating reference voltage, does not cause difficulties.

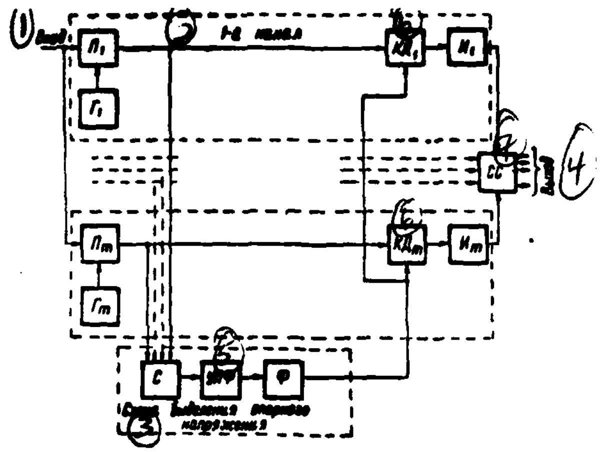
Bibliography

1. Н. Т. Петрович, М. К. Размахнин. Системы связи с шумоподобными сигналами. «Советское радио», 1969.

2. В. Н. Зуев, А. Н. Иощенко, Е. Ф. Квашнин, В. Л. Савиных. Приемное устройство ортогональных широкополосных радиосигналов. Авт. свидетельство № 262940, Кл. 21а', 7/0б МПК НО4l.

3. Л. М. Финк. Теория передачи дискретных сообщений. «Советское радио», 1963.

Figure 1. Block-diagram of the device.



Key: 1 - input; 2 - 1st channel; 3 - system for separating the reference voltage; 4 - output; 5 - UPF; 6 - KD_m; 7 - SS.

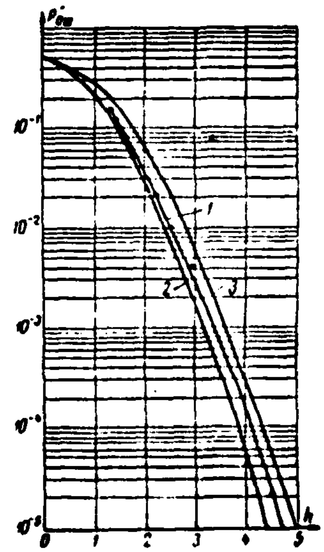


Figure 2. Curves of noise stability.

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